

Testimony of John M. Kimble
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Before the Senate Subcommittee on Production
and Price Competitiveness on Agriculture, Nutrition and Forestry
May 4, 2000

Mr. Chairman, members of the Subcommittee, I am a research soil scientist with the USDA Natural Resources Conservation Service (NRCS) in Lincoln, NE, and it is a pleasure to appear before you to discuss the issue of carbon cycle research and the role of agriculture in helping to mitigate greenhouse gasses. I am presenting this testimony, but it comes from cooperative work of Dr. Ronald Follett, of the Agriculture Research Service, Dr. Rattan Lal, of the Ohio State University, and me, and I would be remiss in not pointing this out. The success we have had is a result of the close cooperation of NRCS, ARS, and The Ohio State University as well as with many other scientists. I strongly feel such cooperation is needed in any future research work.

I have been working with colleagues for the last 10 years dealing with issues related to soil organic carbon and the role that agriculture can play in the sequestration of carbon in the soil both as soil organic carbon (SOC) and soil inorganic carbon (SIC). We have produced several books related to the issue of soils, greenhouse gasses, and carbon sequestration. Two of these books, *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect* by Lal, R., J.M. Kimble, R.F. Follett, and C.V. Cole and *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect* edited by R. F. Follett, J. M. Kimble, and R. Lal, were written to answer questions related to the role of agriculture in carbon sequestration. The complete list of books that have come from a series of meetings we have organized is attached for reference.

These books highlight what is currently known about soils and the carbon cycle. They also list areas where we need to expand our knowledge base so that we can develop recommended management practices to increase the sequestration of carbon in soils. It should be noted that there is a strong linkage of the carbon cycle to the nitrogen and phosphorus cycles and that all three need to be considered together. Many of the problems we have with animal wastes are related to phosphorus and nitrogen, yet the organic matter in the wastes is needed for building

soil carbon. In addition, both nitrogen and phosphorus are required for the photosynthesis process. Photosynthesis fixes atmospheric carbon dioxide in living plants. As plants decompose some of the plant material is converted into soil organic matter. Therefore, an understanding of the three cycles and their interactions is required. We also need to consider the emissions of methane and where this fits in the overall carbon cycle in agriculture. Methane is produced by ruminant livestock during feed digestion, and in wetlands, rice paddies, and animal waste storage facilities. Landfills are the largest single manmade source of methane emissions in the U.S.

We know that soils can sequester carbon. USDA estimates that the potential sequestration range of cropland is in the range of 69.4 to 195 million metric tons of carbon (MMTC)/yr with an average of 132 MMTC/yr, which is about 8 percent of the total U.S. annual emissions of all Green House Gases (GHG's). Grazing lands have the potential to sequester 30 to 110.0 MMTC/yr with an average of 70 MMTC/yr, or about 5 percent of the total annual emissions of all GHG's. Thus, the combined total for cropland and grazing lands is about 13 percent. Sequestration can significantly reduce atmospheric CO₂, and, at the same time, improves soil quality by increasing the carbon in the soil. The increased carbon leads to improved soil fertility, an increased water-holding capacity, reduced soil erosion, restoration of degraded lands, improved water quality, and improved wildlife habitat at the same time that it mitigates the greenhouse effect. This is a win-win scenario with many benefits to agriculture, as well as to society in general.

As outlined in both of the books, we know a great deal about the processes and what is needed to sequester carbon in soils, the overall carbon cycle, and the linkage of the nitrogen and phosphorus cycles, yet there are still many areas that require more research. As stated above, there is an interaction of the carbon and nitrogen cycles. We need to have nitrogen and phosphorus for plant growth, but we need to develop mechanisms to add nitrogen in organic forms, through fixation by plants, or in slow-release forms that mineralize to ammonium while minimizing the amounts present in the nitrate form. Research is needed in the efficiency of fertilizer use. When commercial fertilizers are used, we must consider the amount of CO₂ released in their production and we need to do a full accounting of all inputs. Fertilization will

not be done as a means to increase carbon sequestration but to increase agriculture production, but that still means we need to do a full accounting.

There are many other knowledge gaps that have been identified in our meetings and it is these gaps which point future research needs. In 1996, we identified some areas where these gaps exist. They include (1) tropical ecosystems; (2) frozen soils; (3) wetlands, Histosols, Andisols, and Aridisols soil types; (4) C sequestration in the Subsoil; (5) soil erosion and C dynamics; (6) plant nutrients and their interactions with soil C; (7) soil structure and soil quality indices; (8) methods of soil organic assessment; (9) global database and information exchange; (10) interdisciplinary collaboration; (11) assessment of the value of carbon/ton; and (12) policy options to encourage farmers and land managers to adopt recommended management practices. Questions arising from these knowledge gaps have been answered in part over the last few years, but many still require further research.

We know the value of conservation tillage but still need to look at the potential benefits of different types of tillage systems in different agro-ecological zones, with different crops and crop rotations, and on different soils. This research requires long-term experiments. Research also needs to be conducted on a whole-farm basis. At meetings I have heard farmers say “that these practices work on your small scale experimental station plots, but will they work on my farm on a larger scale?” Researchers need to work with the farmers to look at actual fields, which may have a great deal of soil variability and to see if we can measure changes there.

Conservation Reserve Program (CRP) and other programs have helped to improve and protect highly erodible lands, and they have a high potential for sequestering carbon, but the question is have we gotten the maximum benefit from these lands? Do they need additional management to improve the rates of carbon sequestration? Should limited grazing be allowed to more closely mimic a natural ecosystem in which grazing of grasslands occurs?

Research is needed to determine how fertility testing information can be used to help us understand changes in soil carbon levels. Over 2 million samples are analyzed each year for this purpose. Soil organic matter is one of the things measured during fertility testing. How can we

use these measurements to look at changes in the soil carbon levels over time? We need to look at changes over time on farms using no-till or other conservation tillage systems and on farms using conventional tillage. We need to compare different practices on similar soils. We need to look at carbon changes deeper in the profile. Some studies suggest that there may be gains in the topsoil with no-till but a loss of deeper soil carbon. A major research effort is needed to address this question.

Research is needed to determine why practices that work or are shown to increase the amount of carbon sequestration are not being adopted. Why is the amount of land where no-till has been used being reduced? Is it that farmers do not trust the research, or are they finding yield reductions or some other perceived problem? Again, this question relates to the need for on-farm research with inputs from farmers and land managers to facilitate and answer questions that producers have.

Integrated research is needed to ascertain the value of soil carbon in terms of its effect on production and on other societal values. What is the cost/benefit of carbon sequestration?

How can we use remote sensing to observe land use changes to improve management practices, and to enhance carbon sequestration? Remote sensing allows us to look at the changes at both the farm and at the watershed levels. New remote sensing technology may need to be developed in cooperation with USDA, NASA, and university groups. Projects need to cover broad geographical boundaries that may not fit within one state. Federal agencies (ARS and NRCS) need the funding proposal in the President's proposal for the U.S. Global Change Research Program and the Climate Change Technology Initiative.

We need to see what the effects of irrigation are on carbon sequestration since irrigation can affect both SOC and SIC. Changes in one may be offset by changes in the other. Irrigation is a major land use change, but its long-term effects on carbon are not clearly understood.

We need to look at the effects of bio-energy crops (i.e., switchgrass or even corn) on soil carbon. Production of these crops can help to reduce the dependency on nonrenewable resources. Many grow rapidly and are high yielding, but are they also increasing carbon storage below ground?

Until now, individual research scientists have accomplished a great deal in carbon research. Now is the time for an interdisciplinary approach linking policy makers to soil scientists, agronomists, economists, and plant breeders to develop a systematic research program that can address knowledge gaps and priorities. Research at the farm level requires the input of farmers and ranch managers, and must be geared to the realities of production agriculture.

Research in crop breeding has looked at yield increases, pest control, and water use efficiency. We now need to look at crops that will maintain or increase yields but at the same time increase the amount of biomass below ground or change the overall biomass so that its effectiveness in carbon sequestration is increased (i.e., for example a changing the lignin content of plants).

We need research to develop a process from which to estimate and verify changes in carbon stocks. This will require a research agenda that links many different scientists, working toward a common goal. The future understanding of the global carbon cycle depends on the implementation of a program, which is interdisciplinary in nature drawing on the expertise of these scientists. We need to work at the watershed level or within broad ecological regions, and we need to look at the problems without disciplinary boundaries. We need to take the research from the laboratory and experimental fields to whole-farm operations.

So as you can see, many unanswered questions exist regarding carbon sequestration and finding answers to these questions could provide significant benefits to American agriculture. For this reason, in the FY 2001 Budget, the Administration proposed for USDA \$84 million for the U.S. Global Climate Change Research Program Activities, including \$12 million for NRCS soil carbon inventories, and \$24 million for the Global Climate Change Technology Initiative (an increase of \$11 million), including \$3 million for NRCS pilot projects on crop residue and animal waste management. Providing the requested funding for these activities would be an important step toward improving our understanding of agriculture's role in carbon sequestration.

Mr. Chairman, that completes my statement. I would be happy to answer any questions.